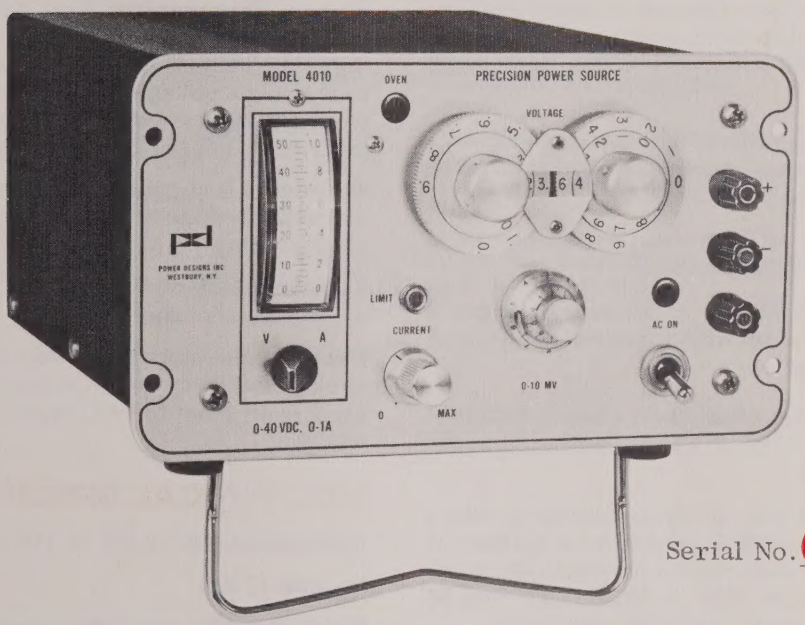
CALIBRATED PRECISION POWER SOURCE

0-40 VDC 0-1 AMPERE

TE000105



Serial No. C108051

GENERAL DESCRIPTION

The Model 4010 is a calibrated precision DC power source designed to combine the accuracy of a 5-digit potentiometric or digital voltmeter with a general purpose power supply.

Critical circuits and components are maintained at a constant ambient temperature in an RFI-free, temperature stabilized chamber.

The output voltage may be remotely resistance programmed with an accuracy of .01%.

The Model 4010 is self-contained in a portable housing designed for bench or rack applications. Panel adapters, 5¼" x 19", are available for mounting one or two units in a standard 19" rack.

Individual calibration data is furnished with each supply. Each unit is burned-in at maximum ratings for 100 hours prior to calibration.

FEATURES

- Four decade switches and a 10-turn potentiometer provide digital readout of the output voltage to six significant figures.
- Sixth place interpolation with 10 microvolt resolution.
- Dial accuracy is 0.1% plus one millivolt up to one volt, 0.1% absolute from one to forty volts.
- Continuously adjustable output current limiter.
- Measurement errors eliminated by flashing indicator which signals output short circuit, overload or current limiter operation.
- Self-restoring electronic overload and short-circuit protection.
- Remote resistance programming at 1000 ohms per volt with an output voltage slewing speed of 1.5 volts per millisecond.
- Front and rear access output terminals.
- Separately fused line and load circuits.

69-11

POWER DESIGNS PACIFIC, INC.
3381 MIRANDA AVE., PALO ALTO, CALIFORNIA 94304

POWER DESIGNS, INC.
1700 SHAMES DRIVE • WESTBURY, N.Y. 11590

ELECTRICAL SPECIFICATIONS

Output: 0 to 40 VDC continuously adjustable at 0 to 1 ampere.

Input: 105 to 125 volts, 47 to 440 Hz, 90 watts nominal.

Regulation: DC voltage change less than 0.001% + 100 microvolts for line variations or load variations over the operating range. Without remote sensing, the load regulation is 250 microvolts at the front panel terminals.

Ripple and Noise: Less than 100 microvolts peak-to-peak at 60 Hz line frequency (measured with an oscilloscope with a bandwidth of 50 MHz).

Resetability: 0.003% or 50 microvolts (whichever is greater) of the original dial setting.

Stability: Better than 0.001% + 100 microvolts per 8 hours; better than 1 mv per week (at constant line, load and ambient temperature).

Source Impedance: Less than .0005 ohms at DC; 0.04 ohms at 20 KHz, 0.5 ohms at 1 MHz (measured at the rear output terminals).

Recovery Time: Less than 30 microseconds to return to within 1 millivolt or 0.005% (whichever is greater) of the set voltage for a step change in rated load (1 microsecond rise time) of 10% to 100%; less than 50 microseconds to return to within 500 microvolts.

Temperature Coefficient: DC output voltage change less than 0.001% or 50 microvolts (whichever is greater) per °C over the range of 0°C to +45°C; less than 0.002% or 100 microvolts (whichever is greater) per °C from +45°C to +60°C.

Current Limiting: 0 to 1 ampere continuously adjustable by a front panel control. Flashing lamp indicates overload or short circuit.

Remote Sensing: Two terminals provided on a rear barrier strip for remote sensing of the voltage at the load.

Remote Programming: Rear panel barrier strip terminals are provided for remote programming of the output voltage. The ratio of programming resistance to the output voltage is 1,000 ohms per volt. Programming accuracy is better than 0.01% of the programming resistance (including the resistance of the leads).

Metering: Front-panel volt-ammeter permits monitoring output voltage or current with an accuracy of ±2% of full scale.

Circuit Protection: The AC line and DC load circuits are separately fused.

Oven: Temperature-controlled oven maintains critical circuits and components at constant ambient temperature even when the AC toggle switch is in the OFF position.

MECHANICAL SPECIFICATIONS

Dimensions: 8⅜" x 4¾" x 11⁹⁄₁₆"

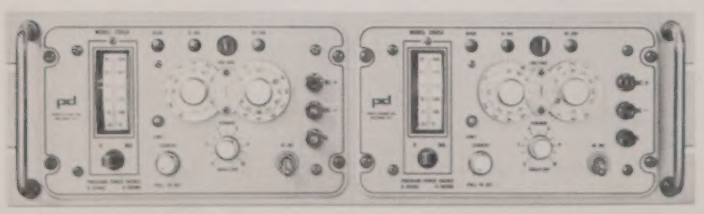
Weight: 12 lbs.

Finish: Brushed, anodized aluminum panel with etched black lettering. Dust cover finished in blue vinyl; chassis and bottom plate, golden iridite.

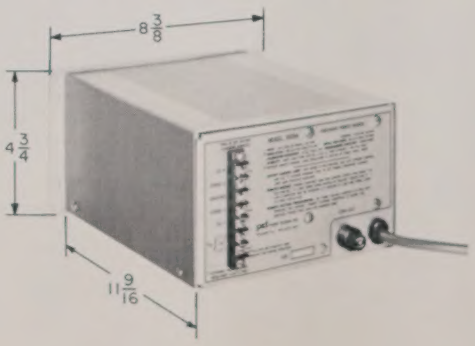
Rack Panel Adapters: Panel adapters are available for mounting either a single unit or two units side by side (as shown).

PRICE: $395.00 F.O.B. Westbury, New York

Prices subject to change without notice



Pair of Model 2005A units shown in type RRG-2 Panel Adapter. Model 4010 may be installed in the same adapter.



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A D D E N D A

POWER SUPPLY

MODEL 4010

The Schematic Diagram has been modified as follows:

1. Capacitors C20 and C21, 0.1 uf, 200 vdc, have been added across CR13 and CR14 on the rear of the amplifier board.

2. Resistor R83, 2.74 k ohms, 1%, $\frac{1}{4}$ w, has been connected between the base of Q10 and the arm of R35.

PRECISION DC POWER SOURCE MODEL 4010

SECTION 1
GENERAL DESCRIPTION

1.1. DESCRIPTION

The Model 4010 is a precision DC power source designed to supply an extremely stable 0 to 40 volt, 0 to 1 ampere output. This instrument combines the accuracy of a precision calibrator with the power capability of a general purpose regulated supply.

Two dual, concentric decade switches provide a digital readout of the selected output voltage to within 0.1% +1 millivolt of the selected value. A 10 millivolt range, ten-turn potentiometer provides interplation of the last place. This potentiometer has a resolution of 10 microvolts.

The output voltage of the supply may be remote programmed with the same accuracy, using an external resistance. The supply also includes provisions for remote sensing of the output voltage at the load.

Compact and light, the power source is self-contained in a portable housing designed for bench use. The modular construction of the Model 4010 makes it suitable for rack mounting. Panel adapters are available for mounting one or two units in a standard 19 inch rack having a panel height of $5\frac{1}{4}$ inches.

A novel bail-handle assembly tilts the front panel for optimum viewing angle and control.

1.2. ELECTRICAL SPECIFICATIONS

OUTPUT: 0 to 40 volts DC, continuously adjustable, 0 to 1 ampere.

INPUT: 105 to 125 volts, 47 to 440 Hz, 90 watts nominal.

REGULATION: DC voltage change less than 0.001% +100 microvolts for line variations of $\pm$10% or load variations of 100% (at sense lead connection points).

RIPPLE AND NOISE: Less than 100 microvolts peak-to-peak measured at 60 Hz.

RESETABILITY: 0.003% or 50 microvolts (whichever is greater) of the original dial setting.

SOURCE IMPEDANCE: Less than 0.5 milliohm at DC, 0.04 ohm at 20 KHz, 0.5 ohm at 1 MHz measured at the rear terminals.

RECOVERY TIME: Less than 30 microseconds to return to within 1 millivolt or 0.005% (whichever is greater) of the set voltage for a step change in rated load (1 microsecond rise time) of 10% to 100%; less than 50 microseconds to return to within 500 microvolts.

STABILITY: Better than 0.001% +100 microvolts per 8 hours; better than 1 millivolt per week (at constant line, load and ambient temperature after warm-up).

TEMPERATURE COEFFICIENT: DC output voltage change less than 0.001% or 50 microvolts (whichever is greater) per ^{o}C over the range of ^{o}C to +45 ^{o}C; less than 0.002% or 100 microvolts (whichever is greater) per ^{o}C from +45 ^{o}C to +60 ^{o}C.

CALIBRATION ACCURACY: Better than 0.1% +1 millivolt.

CURRENT LIMITING: 0 to 1 ampere continuously adjustable front panel control.

OUTPUT TERMINALS: Front Panel - Three insulated binding posts for positive output, negative output and chassis ground. Rear Panel - Screw terminals on a molded barrier block for positive output, negative output, chassis ground, remote voltage programming and remote sensing.

REMOTE SENSING: Two terminals are provided on a rear panel barrier block for remote sensing of the voltage at the load.

REMOTE PROGRAMMING: Rear panel barrier block terminals are provided for remote programming of the output voltage. The ratio of the programming resistance to the output voltage is 1000 ohms per volt. The programming accuracy is better than 0.01% of the resistance value, including the resistance of the programming leads.

METERING: Front panel volt-ammeter monitors the output voltage or current with an accuracy of $\pm$2% of full scale. NOTE: This accuracy is considerably less than that of the power source.

CIRCUIT PROTECTION: The AC line and DC load circuits are separately fused. The AC line fuse is accessible at the rear of the unit. The DC load fuse is accessible on the amplifier board.

INDICATOR LAMPS: Oven Lamp - Lights when AC input is applied and oven heater is energized(operates even when AC ON toggle switch is off). Lamp cycles on and off as oven maintains constant temperature environment for critical components. AC ON Lamp - Lights when AC ON switch is switched on.

1.3. MECHANICAL SPECIFICATIONS

DIMENSIONS: 8-3/8" x 4-3/4" x 11-9/16".

WEIGHT: 12 pounds.

FINISH: Brushed anodized aluminum panel with etched black lettering. Dust cover finished in blue enamel; chassis and bottom plate, golden iridite.

RACK PANEL ADAPTERS: Panel adapters are available for mounting either a single unit or two units side by side.

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SECTION 2
INSTALLATION AND OPERATION

2.1. INSTALLATION

2.1.1. Laboratory Bench: The Model 4010 is a portable unit designed for bench use. No special processing required. The power source is ready for operation as shipped from the factory.

2.1.2. Rack Mounting: Panel adapters are available for mounting one or two units in a standard 19 inch relay rack. Hardware kits are provided with each panel adapter. The power source is fastened to the front surface of the adapter. If the bumper feet or the tilt handle interfere with the assembly of the equipment to the rack, remove them by disassembling the bottom plate of the power source.

2.2. OPERATION

2.2.1. Be sure that the power source is turned off, shorting links connected between the DC+ and S+, 1 and 2 and S- and DC- rear panel terminals, and the screws holding the links are tight.

2.2.2. Set the CURRENT control fully clockwise.

2.2.3. Connect the AC line cord to a source of 105 to 125 volts, 47 to 440 Hz.

NOTE: The OVEN indicator will light as soon as line voltage is applied to the unit, even when the power source is turned off. The indicator will remain on until the oven reaches operating temperature (approximately 10 minutes). The indicator will cycle on and off as the oven maintains a constant temperature environment.

2.2.4. Paragraphs 2.3 through 2.6 give the connections for remote sensing, series operation, remote programming of the output voltage or current limiting.

2.2.5. Place the AC ON switch in the on position.

2.2.6 Set the output voltage to the desired value, using the front panel dials. Set the 0-10MV control to zero if interpolation between 10 millivolt steps is not desired.

2.2.7. Connect the DC+ and DC- terminals (on the front or rear panel) across the load. If desired, connect the positive or negative output terminals to ground.

2.3. SENSING

The regulator circuit maintains the potential between the sense leads (S+ and S-) at the set output voltage. When these leads are connected to the positive and negative output terminals, the power source is connected for local sensing. When the sense leads are connected to the load, the source is connected for remote sensing. Remote sensing is used when an appreciable voltage drop is anticipated in the leads connecting the positive and negative output terminals to the load. The unit is connected for local sensing when shipped from the factory.

2.3.1. For Remote Sensing:

2.3.1.1. Remove the shorting links from the rear panel DC+ and S+, and DC- and S- terminals.

2.3.1.2. Connect the DC+ and DC- leads to the load.

2.3.1.3. Connect the S+ and S- leads to the positive and negative sides of the load, respectively. Run the sense leads as a tightly twisted, shielded pair. Connect the shield to the G (chassis ground) terminal to minimize output ripple.

2.4. SERIES OPERATION

As many as four Model 4010 units may be connected in series to provide up to 160 volts. Connect the positive DC output terminal of one supply to the negative output terminal of the next, in the same manner as connecting batteries in series. The ground terminals on all units may be left floating or tied together and connected to either the most positive or most negative output terminal.

For optimum voltage regulation, disconnect the shorting links between all S+ and DC+ output terminals except those at the most positive potential. Then connect jumper wires between each S+ terminal and S- terminal on the next more positive power source. The voltage drops in the leads connecting the power sources will be compensated for by the regulator circuits of the individual units. For remote sensing, follow these directions, except connect the most positive and most negative S+ and S- leads across the load.

2.5. REMOTE VOLTAGE PROGRAMMING

The output voltage can be programmed remotely by an external fixed or variable resistance as follows:

2.5.1. Turn off the power source. Set all output voltage controls to zero.

2.5.2. Remove the shorting link between the rear panel terminals 1 and 2.

2.5.3. Select a programming resistance by multiplying the desired output voltage by 1000 (the programming constant is 1000 ohms per volt). A constant current of 1 milliampere will flow through this resistance, and the wattage rating should be chosen to minimize drift due to heating. If low output voltages or precise control are required, the resistance of the programming leads should be included in the calculations of the remote resistance value.

2.5.4. Connect the external programming resistance using twisted shielded wire to minimize stray electrostatic or magnetic pickup. Connect the shield to chassis ground (G terminal) to minimize output ripple.

CAUTION: IF THE REMOTE PROGRAMMING CONNECTIONS ARE OPENED WHILE THE SUPPLY IS OPERATING, THE OUTPUT VOLTAGE WILL RISE SLIGHTLY ABOVE THE SET VALUE. WHEN A SWITCH IS USED TO SELECT RESISTORS FOR OUTPUT VOLTAGE PROGRAMMING, CHOOSE ONE WITH SHORTING TYPE CONTACTS TO AVOID VOLTAGE SPIKES.

2.6. CURRENT LIMITING

The maximum output may be limited to a value below 1 ampere as follows:

2.6.1. Connect a short across the DC+ and DC- output terminals.

2.6.2. Turn on the power source and set the meter switch to A.

3.6.3. Adjust the CURRENT control until the meter indicates the maximum desired output current. Remove the short.

SECTION 3
PRINCIPLES OF OPERATION

3.1. GENERAL

The Model 4010 is a highly accurate, series regulated, DC voltage source. It comprises a full wave rectifier circuit, a series regulator circuit and a current limiting circuit.

The series regulator circuit is an electronically variable resistance interposed between the unregulated source and the load. The resistance value is controlled by an amplifier which compares the source output voltage with a reference voltage. The amplifier adjusts the series resistance to reduce the error signal to zero.

The reference voltage is generated by an internal auxiliary power source. The error signal resulting from the voltage comparison is amplified and applied through a driver stage to the series transistor to vary its effective resistance.

3.2. FULL WAVE RECTIFIER OPERATION

The full wave rectifier consists of diodes CR13 and CR14. The output is applied through fuse F2 to series regulator transistor Q5, the output filtered by capacitor C8.

3.3. SERIES REGULATOR OPERATION

The series regulator circuit contains the differential amplifier Q3, amplifiers Q9, Q8 and Q7; drivers Q6 and Q1, and series regulator Q5. The voltage reference for the differential amplifier is zener diode CR9. A constant current is maintained through CR9 by transistor Q2 and zener diode CR10. These components are powered by an auxiliary 20 volt supply.

A 1 milliampere current flows from the DC+ through R40 and the output voltage controls to oven terminal pin 3. This current flows through R14 in parallel with R16 and R17 and establishes a voltage at one base of Q3. The common emitter resistor R13 of Q3 returns to the potential of zener diode CR9. The DC- connects to the opposite end of CR9. Therefore, the voltage from the first base of Q3 to DC- is zero. The second base of Q3 is also at zero volts relative to DC- by virtue of R15.

The differential amplifier, its voltage reference and the transistor which maintains a constant current through the voltage reference are located on the oven board assembly. The oven maintains these components in a constant temperature environment to provide highly stable operation.

The input to the differential amplifier is applied from a voltage divider across the supply output. Any change in output voltage changes the bias on the differential amplifier, and consequently changes the collector current on the output half of this stage. This changes the drive on amplifiers Q9, Q8 and Q7. The changed output of Q7 changes

the drive on Q6 and Q1, and therefore of series regulator Q5. This change in drive on Q5 is in the correct direction to oppose any change in the supply output voltage.

For example, if the output voltage tends to increase, the forward bias on the input stage of the differential amplifier increases. This reduces the collector current of the output half of this stage, reducing the drive of amplifiers Q9, Q8 and Q7. The reduced collector current of Q6 and Q1 reduces the forward bias of series regulator Q5, increasing its effective resistance. The increased resistance of Q5 increases the voltage drop across it, reducing the output voltage.

3.4. CURRENT LIMITING CIRCUIT

The current limiting circuit consists of transistor Q10, the current sensing resistor R26, diodes CR23 and CR17 and their associated components. This stage is powered by the auxiliary 20 volt supply. The current through R26 and the divider consisting of R33, R34 and R35 sets the normal bias on this stage. Potentiometer R33 sets the range of the CURRENT control R35.

When the output load demand exceeds the value set by potentiometer R35, transistor Q10 conducts heavily, turning on diode CR17. With CR17 turned on, Q8, Q7, Q6, Q1 and Q5 are turned off, lowering the output voltage.

Any further increase in load demand further reduces the bias on Q5, further reducing the output voltage. In this manner, the circuit will maintain the load current at the set value for loads down to a short circuit. When the output current demand is reduced, the circuit conditions reverse and the voltage regulating circuits regain control of the output.

SECTION 4
MAINTENANCE

4.1. GENERAL

Under normal conditions, no special maintenance of the Model 4010 is required. If servicing is necessary, read this section before starting repair or calibration.

4.2. ADJUSTMENT AND CALIBRATION

4.2.1. Preliminary Meter Adjustment:

4.2.1.1. Mechanically zero the meter using the mounting screw at the rear of the meter inside the power supply. Pivot friction can be overcome by lightly tapping the meter face.

4.2.1.2. Set the CURRENT control fully clockwise.

4.2.1.3. Connect a 40 ohm, 100 watt resistor, in series with a standard ammeter, across the output of the supply.

4.2.1.4. Switch the AC ON switch on and adjust the output voltage controls for a reading of approximately 1 ampere on a standard ammeter.

4.2.1.5. Set the meter switch to A.

4.2.1.6. Adjust potentiometer R39 (located on the front bottom of the component board) until the panel meter reading is the same as that of the standard ammeter.

4.2.2. Zero Voltage Calibration:

4.2.2.1. Connect a high precision voltmeter across the output of the supply.

4.2.2.2. Set the output voltage controls for 0.000 volt.

4.2.2.3. Switch the AC ON switch on and observe the voltmeter.

4.2.2.4. If the voltmeter does not indicate 0.000 volt ±100 microvolts, adjust potentiometer R10 (multiturn potentiometer on bottom left side toward rear of component board).

4.2.3. 40 Volt Adjustment: (Make this adjustment only after the zero voltage calibration)

4.2.3.1. Adjust the supply output to 40.000 volts. Set the 0-10 MV control fully counterclockwise to 0.

4.2.3.2. Connect a high precision voltmeter across the output of the supply.

4.2.3.3. Switch AC ON switch on and observe the voltmeter.

4.2.4. CURRENT Range Adjustment:

4.2.4.1. Connect ammeter, capable of reading 1.1A accurately, across power supply output.

4.2.4.2. Set the power supply voltage controls to greater than 1 volt.

4.2.4.3. Turn supply on.

4.2.4.4. Adjust CURRENT potentiometer R35 maximum clockwise.

4.2.4.5. Adjust potentiometer R33 until output current is 1.1 A.

4.2.4.6. The CURRENT potentiometer should now be capable of adjusting the output current from 0 to 1.1 A.

4.3. TROUBLE SYMPTOMS AND SUGGESTED REMEDIES

4.3.1. Measure the voltage and resistance as a first step when servicing the supply. Use the data given on the Schematic Diagram in the Appendix.

CAUTION: WHEN UNSOLDERING SEMICONDUCTORS FOR TEST, USE A HEAT SINK TO PREVENT THERMAL DAMAGE. A LONG NOSE PLIERS INSERTED BETWEEN THE SEMICONDUCTOR AND SOLDER JUNCTION IS ADEQUATE. NEVER OPERATE THE SUPPLY WITH LEADS DISCONNECTED OR SEMICONDUCTORS REMOVED. OPERATING POTENTIALS IN THE DC AMPLIFIER MAY CHANGE RADICALLY WHEN A COMPONENT IS REMOVED OR DISCONNECTED.

4.3.2. Power Supply Does Not Go On: If the OVEN Lamp and AC ON lamp do not light, check the AC fuse. If the fuse blows repeatedly, check the oven circuit, diodes CR1, CR13 and CR14, and C3 and C8. Use an ohmmeter to take a resistance reading across each diode. Then, reverse the meter leads and take another reading. If one reading is not at least five times greater than the other, the diode is defective. If one diode in any pair is defective, replace both. A short circuit in one will produce high surge currents in the other with resultant junction damage.

4.3.3. No DC Output Voltage: If the AC ON lamp and OVEN lamp light, but no output voltage is available, be sure that the CURRENT control is not turned fully counterclockwise. Set the meter switch to A and increase the output voltage. If no current is indicated, check the DC fuse F2. If current is present when the output voltage controls are adjusted, check safety diode CR21 and for incorrect programming or sensing connections. Diode CR21 is connected in the opposite polarity to the DC output voltage. If the reverse current flow is greater than 1 ampere, this diode may weld, placing a permanent short circuit across the supply output. Normal operation can be restored by replacing the diode (located on the front terminal binding post board).

4.3.4. Regulator Failure: Check for correct potentials on amplifier transistors, voltage reference, etc. If any voltage appears incorrect, disconnect AC power and check for defective transistors. This

can be done without removing the transistors from the circuit. Using an ohmmeter set to its low resistance scale (R x 1), measure the forward and reverse resistances at the collector-base and base-emitter junctions. A resistance ratio of less than 5 to 1 indicates a defective transistor, which should be checked on a transistor checker.

CAUTION: THIS TEST IS NOT RECOMMENDED FOR HIGH FREQUENCY OR LOW CURRENT DEVICES IN OTHER INSTRUMENTATION, AS CURRENTS FROM SOME OHMMETERS MAY DAMAGE SMALL SEMICONDUCTOR JUNCTIONS.

4.3.5. To test a component located in the oven:

4.3.5.1. Unplug the line cord and remove cover.

4.3.5.2. Loosen the three screws securing the oven cover.

4.3.5.3. Rotate the cover counterclockwise and pull it away from the oven.

4.3.5.4. Remove the two screws which secure the oven cap, remove the cap.

4.3.5.5. Reach into the oven and extract the oven board.

NOTE: To test the oven board while the unit is operating, remove it from its socket and insert a test adapter (Vector Electronic Corp. Type P-9-N-S, or equal) in its place. The board can then be plugged into the adapter.

4.3.5.6. To reassemble the oven, replace the board and cap. Secure the cap in position with two screws. Slide the oven cover down until the screws slide into the slots in the cover. Turn the cover clockwise and tighten the three screws.

4.3.6. Poor Regulation, High Ripple: Make a point-to-point voltage and resistance check. Check all capacitors for open circuits and all electrolytic capacitors for excessive leakage. Make stage-gain measurements by changing the output load current and noting the change in base current of each amplifier stage. Use low resistance milliammeters and microammeters in order not to upset the regulator. The open-loop current gain of the regulator should be more than 10^8 from the base current of the input differential amplifier to the collector current of the series regulator.

A P P E N D I X

1. INTRODUCTION

This Appendix contains an Electrical Parts List, Schematic Diagram, Parts Location Diagram and equipment Warranty.

2. ELECTRICAL PARTS LIST

All electrical and electronic parts are listed in the sequence of their circuit numbers as shown on the Schematic Diagram. A brief description of each part is followed by the code number of the manufacturer and his part number. All manufacturers' code numbers are taken from Cataloging Handbooks H4-1 and H4-2, Federal Supply Code for Manufacturers. They can be obtained from Federal Agencies or ordered directly from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.

We recommend that all parts with the code number 98095 be ordered directly from Power Designs Inc. The commercial equivalents of these parts may have wide parameter tolerances or require special factory inspection or modification before they can be used in the power supply.

All components used in the power supply or supplied as replacements are carefully inspected at the factory, on a 100% basis or at AQL levels to Military Specification MIL-Q-9858, under which Power Designs Inc. has been qualified.

All semiconductors are inspected on a 100% basis, not only for operating parameters, but also for critical characteristics related to reliability and predictable life expectancy. Some of these characteristics are observed when the device is taken beyond its normal operating regions. These test techniques have been developed under a "predictable reliability" program in operation at Power Designs Inc. for the past twelve years. Under this program, quality control procedures are constantly revaluated and updated as advances are made in solid state technology and experience is gleaned from field history.

Semiconductor manufacturers are continually modifying their products. Complete lines are discontinued to be replaced by devices having improved gain, operating voltage levels and frequency responses. The high gain, closed loop DC amplifiers used in regulator circuits are particularly sensitive to slight changes in these parameters. Commercial or military "equivalent" transistors may affect the performance of the power supply. We can assure compliance with the original specifications if replacement semiconductors are ordered from the factory.

All replacement semiconductors are processed and stocked at the factory for complete interchangeability with the devices in the original equipment. To insure identical replacements, the original devices are coded with a Power Designs Inc. part number. For example:

MS	1028	A
Semiconductor Manufacturer's Code	Power Designs Inc. Type	Suffix denoting special parameters

When ordering replacements, please identify the device as thoroughly as possible, listing the model and serial number if available.

The replacement part received may have a part number which differs from that given on the Electrical Parts List. This can be due to several factors:

a. A different prefix indicates that Power Designs Inc. is using another vendor source. The operating characteristics of the devices are the same.

b. A completely different part number indicates:

1. The original vendor has discontinued manufacture of the item or can no longer manufacture it to the original specifications.

2. A better device for use in the particular circuit has been substituted.

3. Tighter controls for interchangeability mean greater assurance of reliability with the replacement.

ELECTRICAL PARTS LIST

NOTE: Before replacing semiconductors, see paragraph 2 of this Appendix.

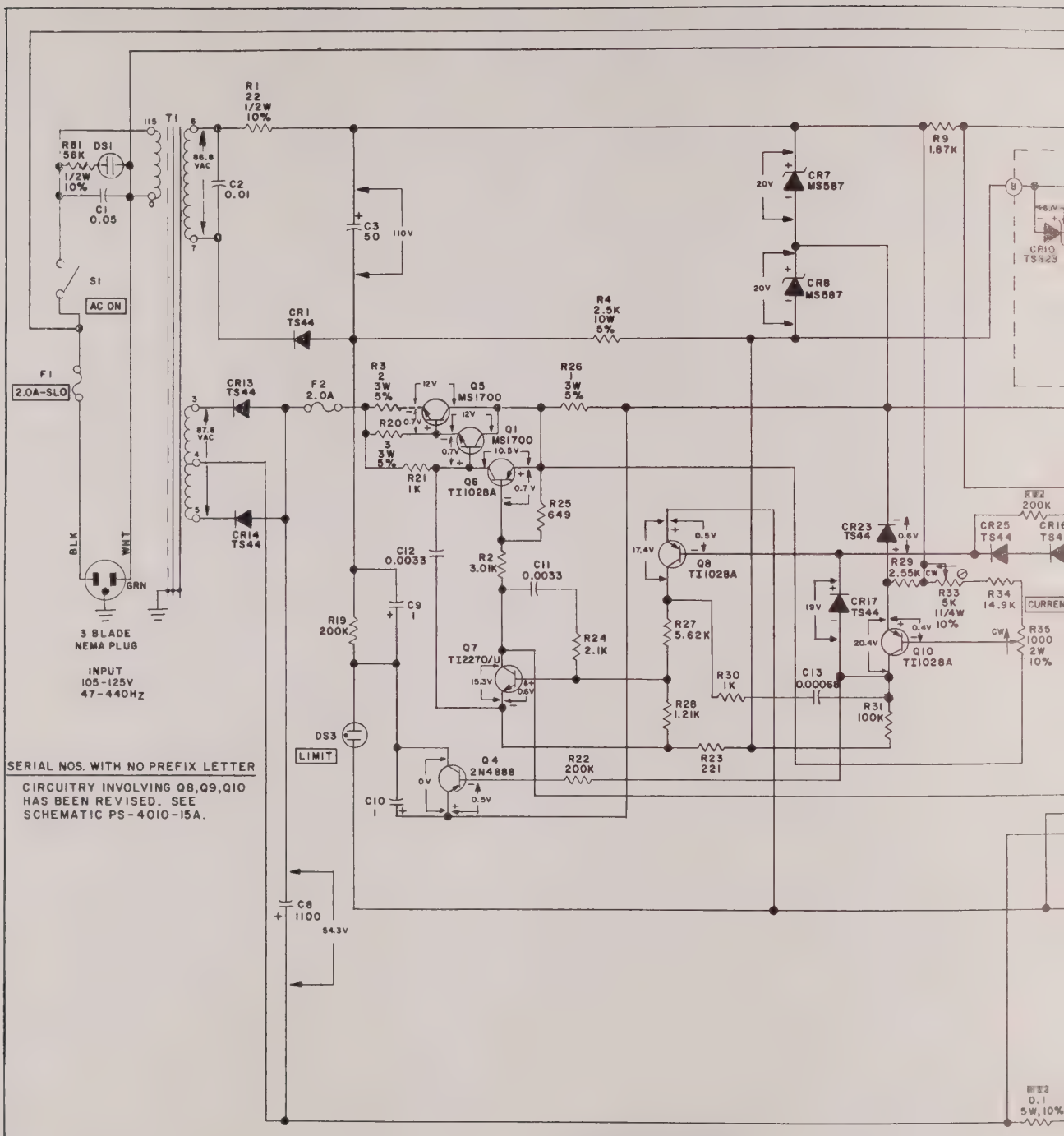
Circuit Number	Description	Mfr Code Number	Part Number
A1	Oven board assembly	98095	PS-2005A-13(A
C1	Capacitor,ceramic disc,0.05 uf,600 vdc	98095	CC-34-6
C2	Capacitor,ceramic disc,0.01 uf,1 kvdc	98095	CC-A01-102
C3	Capacitor,electrolytic,50 uf,150 vdc	98095	CE-86-1.5
C8	Capacitor,electrolytic,1100 uf,75 vdc	98095	CE-34-.75
C9,C10	Capacitor,electrolytic,1 uf,100 vdc	98095	CE-59-1
C11,C12	Capacitor,plastic film,0.0033 uf,200 vdc	98095	CP-18-2
C13	Capacitor,plastic film,680 pf,200 vdc	98095	CP-27-2
C14	Capacitor,plastic film,6 uf,100 vdc	98095	CP-6-101
C15	Capacitor,electrolytic,680 uf,50 vdc	98095	CE-681-50
C16	Capacitor,electrolytic,51 uf,50 vdc	98095	CEX-51-50
C17,C18	Capacitor,ceramic disc,0.1 uf,200 vdc	98095	CC-24-2
C19	Capacitor,ceramic disc,10 pf,600 vdc	98095	CC-14-6
C20,C21	Capacitor,plastic film,0.1 uf,200 vdc	98095	CP-17-2
CR1	Diode, silicon	98095	TS44
CR7,CR8	Diode, silicon, zener	98095	MS587
CR9	Diode, silicon, zener	98095	TS823H2
CR10	Diode, silicon, zener	98095	TS823
CR11	Diode, silicon	98095	TS44
CR12	Diode, silicon, zener	98095	TS823G
CR13,CR14	Diode, silicon	98095	TS44
CR16 thru CR20	Diode, silicon	98095	TS44
CR21	Diode, silicon	98095	SI-5A2
CR22,CR23	Diode, silicon	98095	TS44
CR24	Silicon controlled rectifier	98095	TIC47
CR25,CR26	Diode, silicon	98095	TS44
DS1,DS2	Indicator lamp	98095	PLA-13
DS3	Indicator lamp	98095	PLA-15
F1	Fuse, 2 amperes, Slo-Blo	71400	MDL-2
F2	Fuse, 2 amperes, Fast-Blo	71400	AGC2
M1	Meter	98095	MVA-131
Q1	Transistor, silicon, NPN	98095	MS1700
Q2	Transistor, silicon, NPN	98095	TI-2270/U
Q3	Transistor, dual, silicon, NPN	98095	MS2916
Q4	Transistor, silicon, PNP	98095	2N4888
Q5	Transistor, silicon, NPN	98095	MS1700
Q6	Transistor, silicon, PNP	98095	TI-1028A
Q7	Transistor, silicon, NPN	98095	TI-2270/U
Q8	Transistor, silicon, PNP	98095	TI-1028A
Q9	Transistor, dual, silicon, NPN	98095	MS2916
Q10	Transistor, silicon, PNP	98095	TI-1028A
Q11	Transistor, silicon, NPN	98095	TI-2270/U
R1	Resistor,composition,22 ohms,10%,½ w	01121	EB2201

Circuit Number	Description	Mfr Code Number	Part Number
R2	Resistor,precision,metal film,3.01k ohms,1%,⅛w	98095	RD-3011-10A
R3	Resistor,wirewound,2 ohms,5%,3 w	98095	RW-020-3KA
R4	Resistor,wirewound,2.5 k ohms,5%,10 w	98095	RW-252-3EA
R6	Resistor,precision,metal film,715 ohms,1%,¼ w	98095	RD-7150-10A
R7	Resistor,precision,metal film,66.5 k ohms,1%,⅛w	98095	RD-6652-10A
R8,R9	Resistor,precision,metal film,1.87 k ohms,1%,⅛w	98095	RD-1871-10A
R10	Resistor,variable,wirewound,10 k ohms,5%,3/4w	98095	RWV-103-3X(PC)
R11,R12	Resistor,precision,metal film,200 k ohms,1%,⅛w	98095	RD-204-10A
R13	Resistor,precision,metal film,100 k ohms,1%,⅛w	98095	RD-104-10A
R14	Resistor,precision,wirewound,7.20 k ohms,0.1%, 1/3w	98095	RD-722-8S
R15	Resistor,precision,metal film,100 ohms,1%,¼ w	98095	RD-101-10A
R16	Resistor,precision,wirewound,49.9kohms,1%,1/3w	98095	RW-4992-80
R17	Resistor,variable,wirewound,10 k ohms,5%,3/4w	98095	RWV-103-3X(PC)
R18,R19	Resistor,precision,metal film,200k ohms,1%,⅛w	98095	RD-204-10A
R20	Resistor,wirewound,3 ohms,5%,3 w	98095	RW-030-3KA
R21	Resistor,precision,metal film,1 k ohm,1%,¼w	98095	RD-102-10A
R22	Resistor,precision,metal film,200 k ohms,1%,⅛w	98095	RD-204-10A
R23	Resistor,precision,metal film,221 ohms,1%,¼ w	98095	RD-2210-10A
R24	Resistor,precision,metal film,2.1 k ohms,1%,⅛w	98095	RD-212-10A
R25	Resistor,precision,metal film,649 ohms,1%,¼ w	98095	RD-6490-10A
R26	Resistor,wirewound,1 ohm,5%,3 w	98095	RW-010-3KA
R27	Resistor,precision,metal film,5.62 k ohms,1%,⅛w	98095	RD-5621-10A
R28	Resistor,precision,metal film,1.21 k ohms,1%,⅛w	98095	RD-1211-10A
R29	Resistor,precision,metal film,2.55 k ohms,1%,⅛w	98095	RD-2551-10A
R30	Resistor,precision,metal film,1 k ohm,1%,⅛w	98095	RD-102-10A
R31	Resistor,precision,metal film,100 k ohms,1%,¼ w	98095	RD-104-10A
R32	Resistor,wirewound,0.1 ohm,10%,5 w	98095	RW-0F1-4DA
R33	Resistor,variable,wirewound,5 k ohms,10%,1½w	98095	RWT-502-C4
R34	Resistor,precision,metal film,14.9 k ohms,1%,⅛w	98095	RD-1492-10A
R35	Resistor,variable,wirewound,1 k ohm,10%,2 w	98095	RWV-102-C4.87
R36	Resistor,precision,metal film,45.3 k ohms,1%,⅛w	98095	RD-4532-10A
R37	Resistor,precision,metal film,29.4k ohms,1%,⅛w	98095	RD-2942-10A
R38	Resistor,precision,metal film,49.9k ohms,0.5% ¼ w	98095	RD-4992-60A
R39	Resistor,variable,wirewound,50 ohms,10%,1½w	98095	RWT-500-C4
R40	Potentiometer,wirewound,10 ohms,10 turn	98095	B69016
R41	Resistor,precision,wirewound,10 k ohms,0.01%, 0.4 w	98095	RW-103-13UR
R42	Resistor,prec.,wirewound,1 k ohm,0.1%,0.4 w	98095	RW-102-8UR
R43,R44	Resistor,prec.,wirewound,2 k ohms,0.1%,0.4 w	98095	RW-202-8UR
R45	Resistor,prec.,wirewound,5 k ohms,0.1%,0.4 w	98095	RW-502-8UR
R46	Resistor,composition,4.7 k ohms,10%,¼ w	01121	CB4721
R47	Resistor,composition,6.8 k ohms,10%,¼ w	01121	CB6821
R48	Resistor,composition,27 k ohms,10%,¼ w	01121	CB2731
R49	Resistor,composition,18 k ohms,10%,¼ w	01121	CB1831
R50	Resistor,precision,wirewound,100 ohms,0.1%,0.4w	98095	RW-101-8UR
R51,R52	Resistor,prec.,wirewound,200 ohms,0.1%,0.4 w	98095	RW-201-8UR
R53	Resistor,prec.,wirewound,500 ohms,0.1%,0.4 w	98095	RW-501-8UR
R54	Resistor,composition,470 ohms,10%,¼ w	01121	CB4711
R55	Resistor,composition,680 ohms,10%,¼ w	01121	CB6811
R56	Resistor,composition,2.7 k ohms,10%,¼ w	01121	CB2721

Circuit Number	Description	Mfr Code Number	Part Number
R57	Resistor, composition, 1.8 k ohms, 10%, ¼ w	01121	CB1821
R58	Resistor, precision, wirewound, 10 ohms, 1%, 0.4 w	98095	RW-100-1UR
R59, R60	Resistor, prec., wirewound, 20 ohms, 0.5%, 0.4 w	98095	RW-200-6UR
R61	Resistor, prec., wirewound, 50 ohms, 0.5%, 0.4 w	98095	RW-500-6UR
R62	Resistor, composition, 47 ohms, 10%, ¼ w	01121	CB4701
R63	Resistor, composition, 68 ohms, 10%, ¼ w	01121	CB6801
R64	Resistor, composition, 270 ohms, 10%, ¼ w	01121	CB2711
R65	Resistor, composition, 180 ohms, 10%, ¼ w	01121	CB1811
R66	Resistor, prec., wirewound, 20 k ohms, 0.01%, 0.4 w	98095	RW-203-13UR
R67	Resistor, composition, 47 k ohms, 10%, ¼ w	01121	CB4731
R74	Resistor, prec., metal film, 100 k ohms, 1%, ¼ w	98095	RD-104-1QA
R75	Resistor, composition, 27 k ohms, 10%, ½ w	01121	EB2731
R76	Resistor, prec., metal film, 3.01 k ohms, 1%, ¼ w	98095	RD-3011-1QA
R77	Resistor, composition, 56 k ohms, 10%, ½ w	01121	EB5631
R79	Resistor, prec., metal film, 1 k ohm, 1%, ¼ w	98095	RD-102-1QA
R80	Resistor, prec., metal film, 10 k ohms, 1%, ¼ w	98095	RD-103-1QA
R81	Resistor, composition, 56 k ohms, 10%, ½ w	01121	EB5631
R82	Resistor, prec., metal film, 200 k ohms, 1%, ¼ w	98095	RD-204-1QA
R83	Resistor, prec., metal film, 2.74 k ohms, 1%, ¼ w	98095	RD-2741-1QA
S1	Switch, SPST	98095	ST-5
S2	Switch, DPDT	98095	ST-26
S5	Switch, rotary	98095	PS-2005-7-5
S6	Switch, rotary	98095	PS-2005-7-4(D)
T1	Transformer	98095	TTM-4010-5(B)
TB1	Terminal Block	75382	599-2004-7
Z1	Oven Assembly	98095	PS-2005A-37
	Oven	98095	PS-75-10-EC

CODE LIST OF MANUFACTURERS

01121	Allen-Bradley Company	Milwaukee, Wisconsin
71400	Bussman Manufacturing Division	St. Louis, Missouri
75382	Kulka Electric Corporation	Mt. Vernon, New York
98095	Power Designs Inc.	Westbury, New York



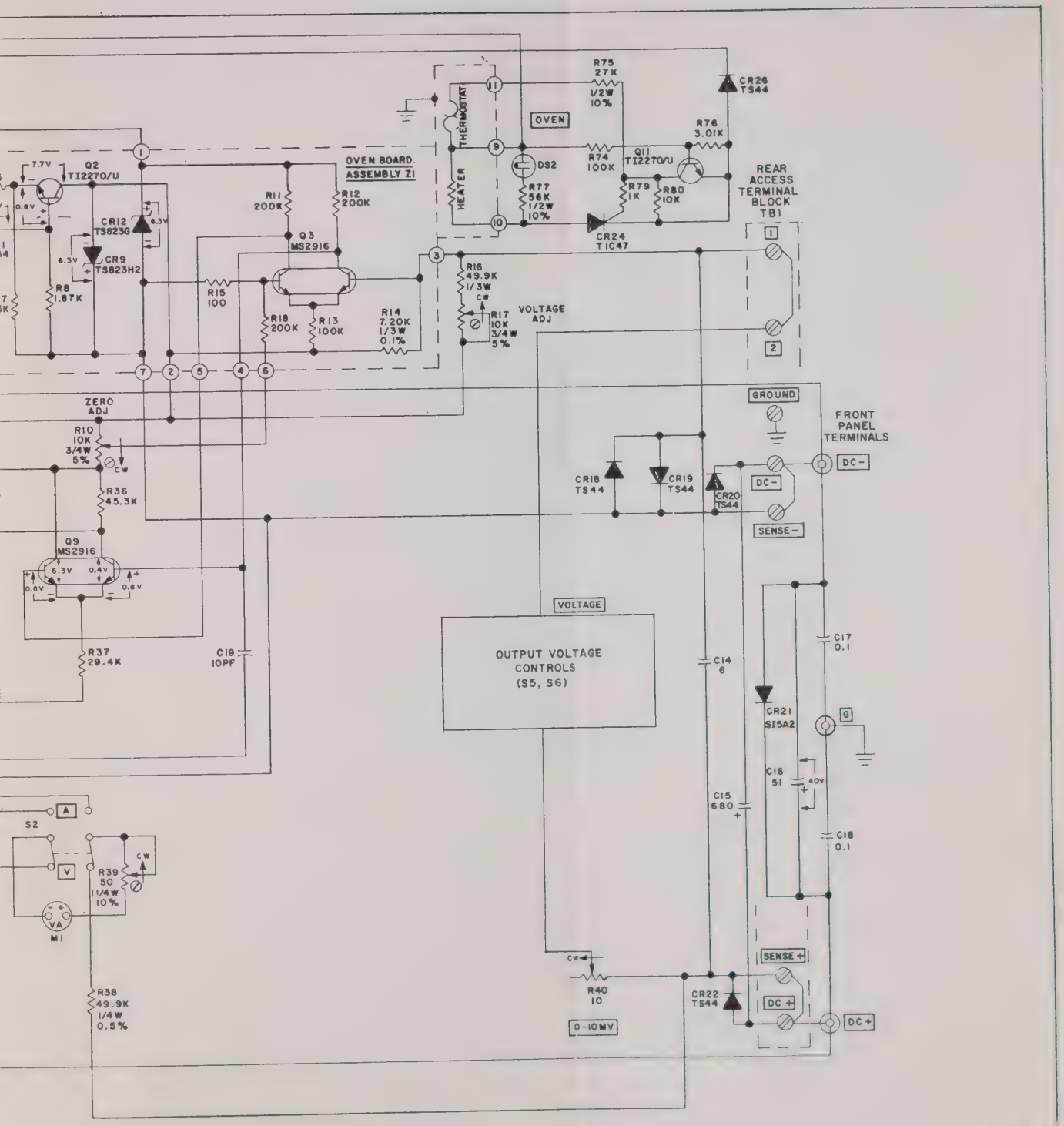
SERIAL NOS. WITH NO PREFIX LETTER

CIRCUITRY INVOLVING Q8, Q9, Q10 HAS BEEN REVISED. SEE SCHEMATIC PS-4010-15A.

UNLESS OTHERWISE SPECIFIED:

ALL RESISTORS ARE IN OHMS, 1/4W, 1%
ALL CAPACITORS ARE IN MICROFARADS

VOLTAGES INDICATED ARE MEASURED WITH 115 VAC INPUT AND 40 VDC OUTPUT WITH A 1A LOAD. MEASUREMENTS MADE WITH A 1 MEGOHM MIN. INPUT IMPEDANCE METER FOR DC AND 1000/VOLT METER FOR AC. VOLTAGES ARE DC EXCEPT WHERE OTHERWISE INDICATED.



SHEET 1 OF 2

SYM	DESCRIPTION	APPD	DATE
C	REVISED, ECN 1719		
B	REVISED, ECN 1714		
A	RELEASED		

REVISIONS

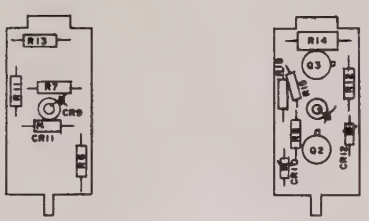
DRAWING NO. PS-4010-15 REV C

TITLE SCHEMATIC, MODEL 4010

PRECISION POWER SOURCE, 0-40 VDC, 0-1A

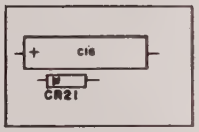
DRAWN	CHECKED	APPROVED
DATE 2/22/69	DATE 7/21/69	DATE 7-24-69

Power Designs Inc.
NEW YORK



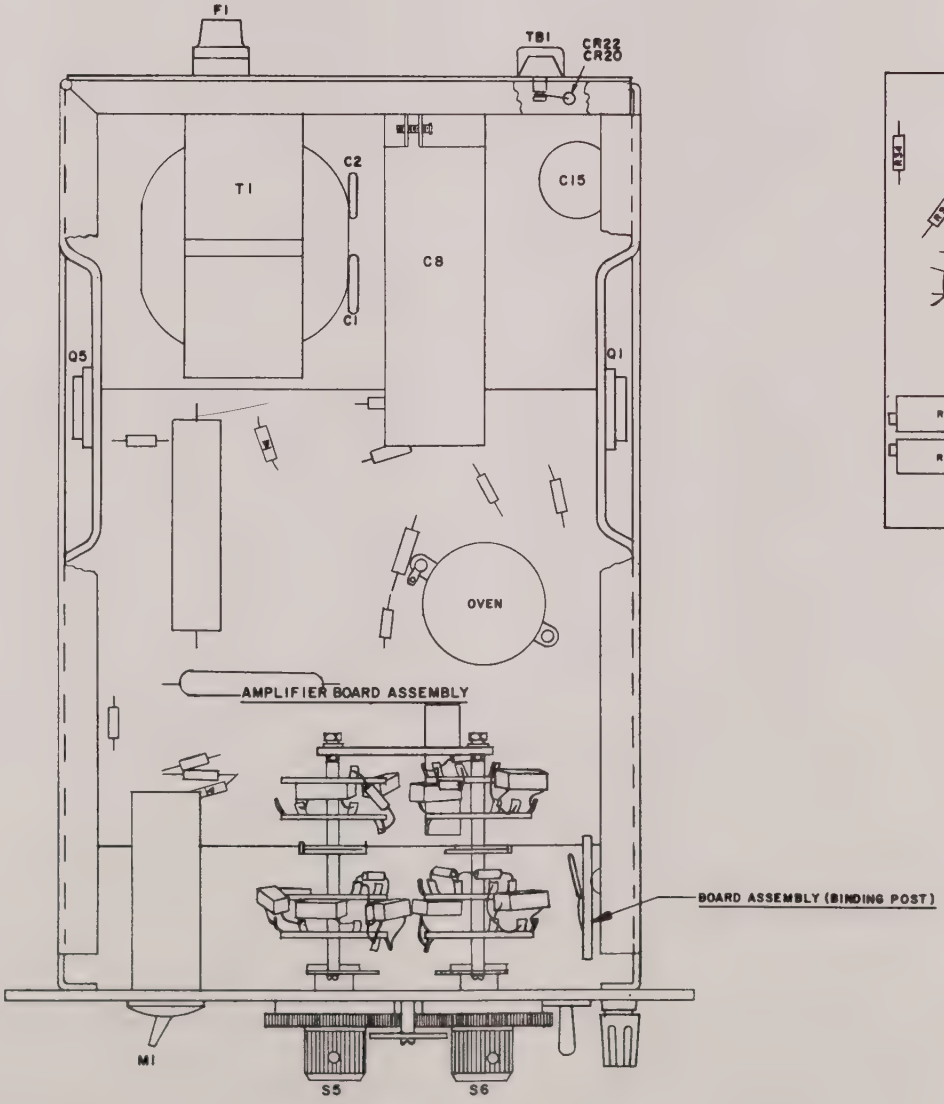
FRONT VIEW REAR VIEW

OVEN BOARD ASSEMBLY
PS-2005A-13

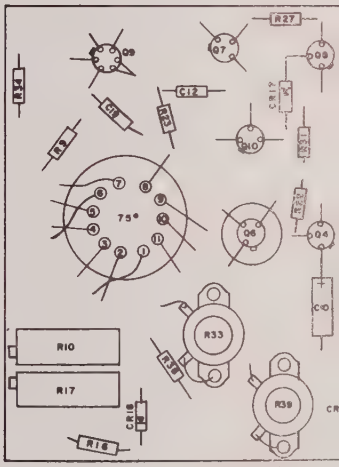


FRONT VIEW

BOARD ASSEMBLY (BINDING POS
PS-4010-28

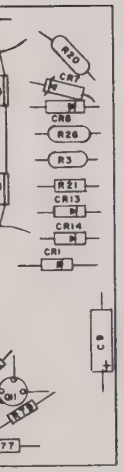


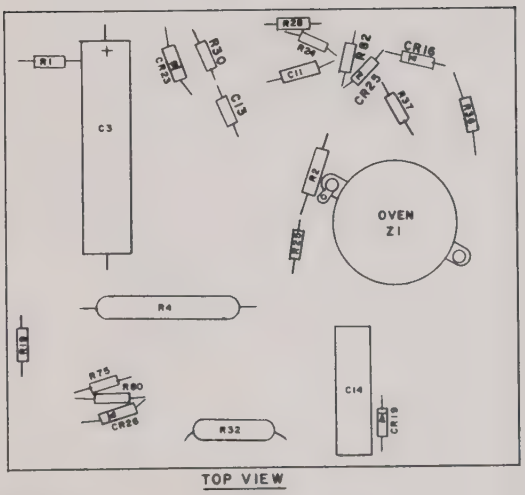
LOCATION OF COMPONENTS
TOP VIEW OF CHASSIS



BOTTOM VIEW

IEW





TOP VIEW

AMPLIFIER BOARD ASSEMBLY
PS- 4010 -8

SHEET 2 OF 2

SYM	DESCRIPTION	APPD	DATE
C	REVISED, ECN 1719		
B	REVISED, ECN 1714		
A	RELEASED		

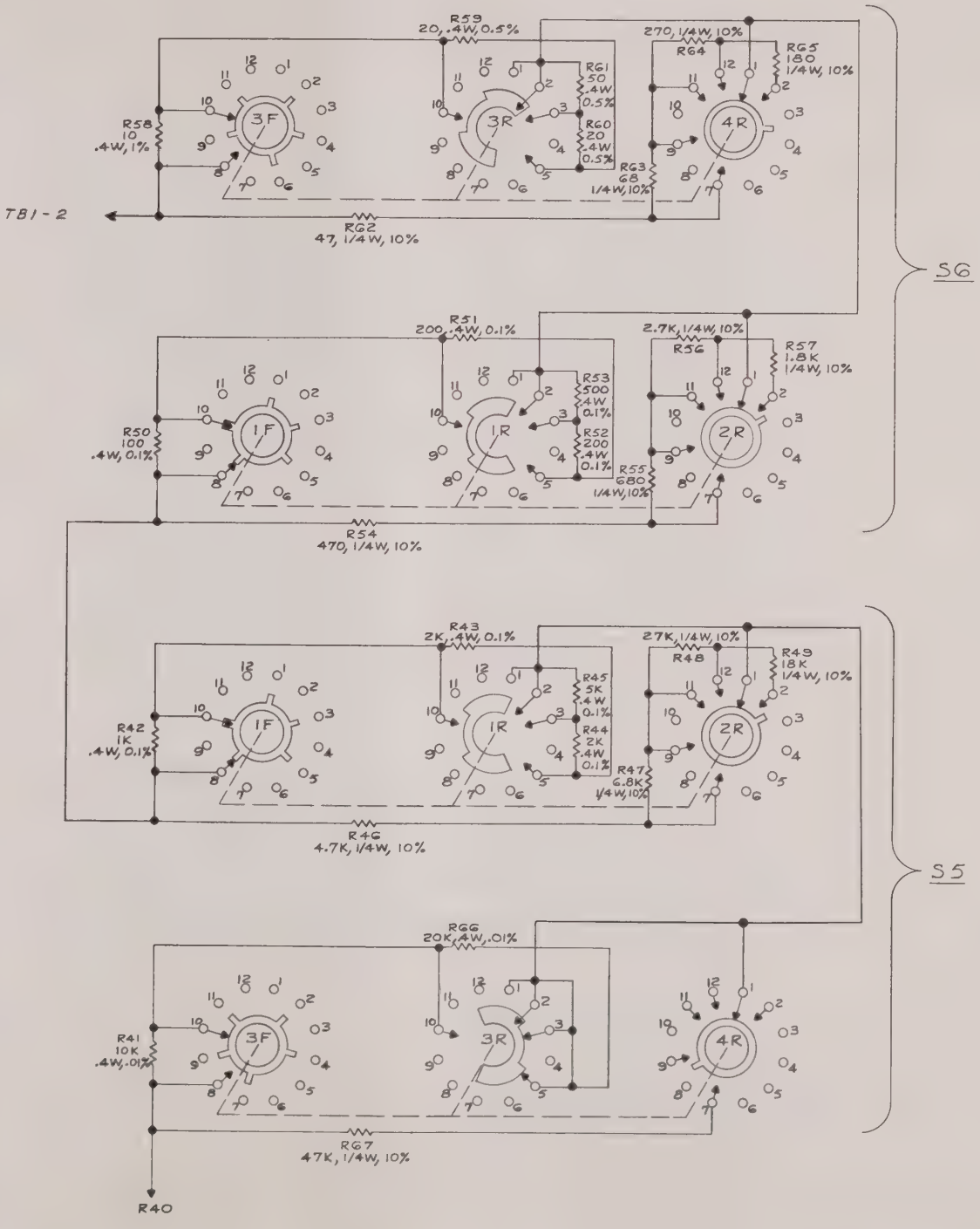
REVISIONS

DRAWING NO. PS-4010-15 REV. C

TITLE LOCATION OF COMPONENTS MODEL 4010 SCALE

DRAWN	CHECKED	APPROVED
DATE 11/30/69	DATE 12/1/69	DATE 12/2/69

Power Designs Inc.
NEW YORK



MAXIMUM CLOCKWISE POSITION
AS VIEWED FROM KNOB END

VOLTAGE CONTROL WIRING FOR MODEL 4010

B	REVISED, ECN 1747		
A	RELEASED		
	REVISIONS		

DRAWING NO PS 4010-27 B
TITLE S5 & S6 SWITCH LAYOUT
PART NO DIAGRAM, INSTR MANUAL SCALE
DRAWN JD CHK'D APPROVED
DATE 7/25/67 DATE 7/26/67 DATE 8/1/67

Power Designs Inc.
NEW YORK

WARRANTY

POWER DESIGNS INC., warrants to the original purchaser, each instrument sold by us, or our authorized agents, and all the parts thereof, to be free from defects in material or workmanship under normal use and service within the specified ratings and operating conditions.

Its obligation under this warranty is hereby limited to the repair or replacement of any instrument, or part thereof, which is returned to us within one year after delivery, and which shall prove, after our examination, to be thus defective.

This warranty does not include the cost of transportation charges to and from the factory and/or the cost of packaging or crating of instruments for return to the factory, unless such instrument is returned within thirty (30) days from the date of original shipment as shown on the packing list or shipping documents, and prior written authorization for such costs is obtained from the factory.

The repair or replacement of an instrument, or any part thereof, does not void or extend the original warranty.

POWER DESIGNS INC., reserves the right to discontinue any instrument without notice, or to make modifications in design at any time, without incurring any obligation to make these modifications in instruments previously sold.

POWER DESIGNS INC.
Westbury, L. I., New York

POWER DESIGNS PACIFIC, INC.
Palo Alto, California

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3000 Scott Boulevard, Suite 113
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(303) 388-4081
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(505) 268-3941
Phoenix, Arizona 85004
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(602) 253-6104
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Indianapolis, Indiana 64220
1111 E. 54th Street
(317) 253-2087

(5) EIR, INC.
Maitland, Florida 32751
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(305) 644-9595

(6) HARVEY TEPLITZ+CO, INC.
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Huntington, Fulton Cty, Pa. W.
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Cleveland, Ohio 44118
3945 Meadowbrook Blvd.
(216) 371-6531, 32
Detroit, Michigan 48240
26847 Grand River Ave.
(313) 537-9058

(7) Q.E.D. ELECTRONICS, INC.
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N.Y.; Fairfield Cty, Ct.;
Tioga, Lycoming, Union,
Mifflin, Juniata, Franklin
Counties, Pennsylvania
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(914) 664-0080
Camden, N. J. 08105
2916 Federal Street
(215) 925-8711
Silver Spring, Md. 20910
850 Sligo Ave., Room 300
(301) 588-8134

(8) OSSMANN INSTRMNTS, INC.
Syracuse, N. Y. 13057
6666 Old Collamer Road
(315) 437-6666
Rochester, N. Y. 14619
474 Thurston Road
(716) 328-2230
Vestal, New York 13850
Vestal Parkway East
(607) 785-9947
Wappingers Falls, N.Y. 12590
122 E. Main Street
(914) 297-7777

(9) HOWARD J SCHUFT CO, INC.
Newtonville, Mass. 02160
815 Washington St.
(617) 527-5304, 5
New Haven, Conn. 06514
965 Dixwell Avenue
(203) UN 5-1365

(10) COMPUTING DEVICES OF
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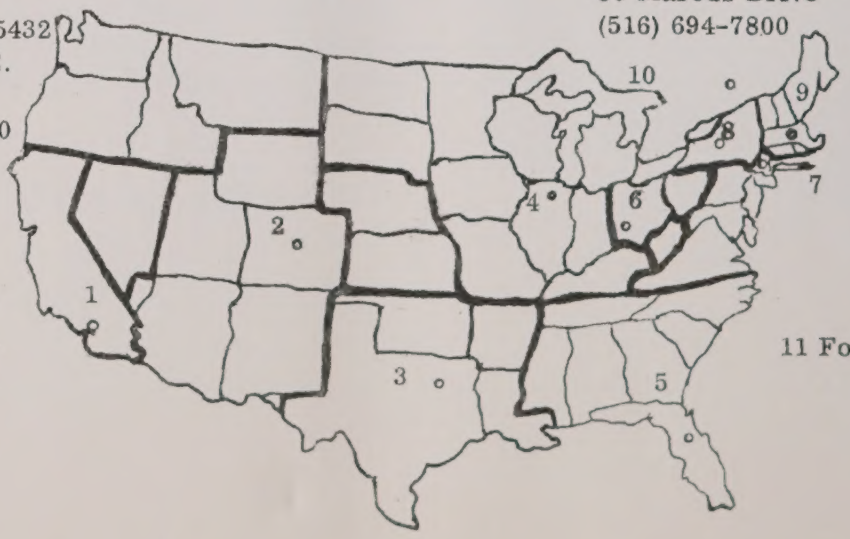
P.O. Box 508
(613) 828-9143
Dartmouth, Nova Scotia
P.O. Box 763
(902) 466-7461
Vancouver 4, B. C.
683 East Hastings Street
(604) 255-7366

(11) ROCKE INTNL CORP.
Melville, L.I., N.Y. 11746
80 Marcus Drive
(516) 694-7800



11 Foreign

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POWER DESIGNS

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